

**Energy Embeddedness:
How Social Relationships Influence Energy Usage**

by

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Access to reliable energy is considered fundamental to a modern standard of living and rural electrification has become a central goal of development. Prior studies suggest that with increased energy access, women stand to gain particularly due to their connection to energy-intensive work in the home. However, these studies focus only on the extent of access to households and not how family members within the home are using the electricity. This research focuses on the social relationships between family members to better understand electricity usage particularly for women who should, in theory, have the most to gain from modern energy access. In a detailed inductive study of 31 women and additional stakeholders in the State of Gujarat in India, we find that access within a home does not mean equitable usage by all household members. From these findings, we propose a new concept of energy embeddedness, whereby we argue social relationships influence the energy behavior of families. Using this concept, we advance a novel 2x3 framework that distinguishes appliances based on their costs that largely influence access and the social relationships around them that largely influence usage. From this study, we hope to help make rural electrification policies more sensitive to the nuances between usage and access to advance energy policy that truly reaches all.

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1.0 INTRODUCTION

Access to reliable energy is considered fundamental to economic growth. Heightened access to energy enables working longer hours, greater efficiency in daily tasks, and more accessible information, which is associated with several positive development outcomes such as increased income, improved health, and greater educational attainment¹ ([Mathur 2005](#); [Bilolika 2014](#); [Banerjee 2015](#)). Despite the continuous push for more people to gain access to electricity, the International Energy Agency reports an estimated 1.3 billion people living without access to electricity worldwide. Predominantly, access in urban areas far outpaces that of rural areas both in number and in quality. Thus, a main focus of existing research is how to bridge this gap to ensure increased access to electricity. From this, the key topics in energy access research are energy markets, public policy mechanisms, and energy pricing, which largely address access through economic affordability with cost being assumed as the main barrier to access ([Sovacool 2014](#)). Overall, the prevailing view is that by resolving financial barriers, more can access energy and realize economic growth.

In addressing issues of costs, energy research in developing countries further argues that women are the expected primary benefactors from heightened energy access ([Bose 1993](#), [Desai and Jain 1994](#); [Berthaud et. al. 2004](#); [Dinkelman 2011](#); [Kohlin et. al. 2012](#)). These various studies and reports show that increased electricity provision improves the likelihood of women to engage in activities that promote their learning, health, leisure, and income. Women can engage more in these activities because these studies assume that the introduction of household electrification

1

reduces the amount of time spent on women-dominated, time-intensive tasks such as water, fuel collection, and cooking ([Mathur, 2005](#); [Kaygusuz 2011](#), [Prayas, 2014](#)). The common perception then is that solving access issues will asymmetrically benefit women, which should alleviate gender inequality. Although many studies have examined women's use of their time and their labor force participation before and after electrification ([Bose 1993](#); [Kohlin et. al. 2011](#), [Parikh 2011](#); [Burke and Dundas 2015](#)), none that I am aware of have directly inspected the actual household usage of electricity through the lens of women to directly verify these assumptions.

This prevailing focus on access does not fully address issues of how energy is then used after gaining access. Some more recent research is arguing that social barriers may play a more important role in usage than access ([Khandker et. al. 2010](#); [Sadath and Acharya 2017](#)). Yet, there has been no detailed work to understand how consumption patterns across household members evolve and how that may, in turn, restrict energy access to certain family members over others. Through a better understanding of energy usage, rather than just access, we can better understand not just the economic but social barriers to energy. Moreover, we can more accurately ascertain whether modern energy is universally used by the entire household, both men and women.

Given both the lack of theory and empirics around the issues, I conducted an inductive study in Gujarat, India to investigate intra-household usage of electricity. In documenting every electrical appliance in each respondents' households and who uses it, I was able to distinguish between those factors that affect access, namely affordability, and those that affect usage, which are often driven by social relationships within the family rather than costs. Overall, in combining issues of access with issues of usage, the aim of my study is to overcome the lack of social science integration into energy research that has narrowed the perspective of how we approach and analyze issues of energy in development ([Sovacool 2014](#)).

How then do we understand energy usage as distinct or similar from energy access? To develop a framework that better considers usage and access, I bring in work from economic sociology, namely embeddedness, that has yet to be adequately applied to issues of energy. Embeddedness is the notion whereby social relationships and norms underlie economic activity. I argue just as social relationships underlie economic activity, these relationships may also underlie how different individuals use energy. I use this concept to distinguish between issues of access that are influenced by economics and issues of usage that I posit are influenced by this strand of sociology. In this manner, I use social relationships between family members as a means to better understand electricity usage particularly for women who should, in theory, have the most to gain from energy access. In focusing on usage, I find that social relationships rather than costs alone drive energy behavior. I then discuss the implications of these findings through proposing a novel 2 x 3 framework that I hope advances our understanding of the role of energy in development through newfound attention to social relationships in this process.

1.1.1 Empirical Context: India

Of the approximately 1.3 billion people in the world without access to electricity, 304 million live in India, making it the country with the largest un-electrified population in the world (though as a region sub-Saharan Africa has 621 million people without access to electricity). These low levels of access to electricity are reflective of the increasing inequality in India, whereby the country's rapid growth has been concentrated in urban areas. Indeed, according to World Bank data, 93 percent of those living in India without electricity access reside in rural areas (with those living in rural areas accounting for 70 percent of the Indian population). Such large rural-urban divide in electricity access stems largely from India's post-independence focus on urban

electrification for the development of industry. It was not until the 1970s that India began to focus on extending the electricity grid to rural households.

Rural electrification efforts in India are managed by the Rural Electrification Corporation through numerous efforts primarily focused on centralized grid expansion (Appendix 1). Centralized grid extension requires sizable initial investments and more intensive maintenance due to remoteness of rural areas. Moreover, because rural consumers tend to emanate from lower income brackets, revenue generation to economically sustain such systems is minimal. Consequently, the success of rural electrification efforts in India has been limited and there still exists a pervasive lack of incentives to extend the service to rural areas and the rural poor.

1.1.2 Site Justification: Gujarat's Electrification Status

Appendix 2 provides a ranking of Indian states by percentage of population with electricity access. The state of Gujarat has been hailed not only for extending electricity access to its rural areas, but also providing a greater amount of continuous quality power supply than most states (["Power Distribution Reforms in Gujarat" 2009](#)). In fact, people living in rural areas in the state of Gujarat have lived with high-quality electricity access for almost 15 years now since the landmark 2003 Jyotigram Yojana initiative. As such, the state provides a good setting for my study, which aims to evaluate how access to electricity affects different household members. 62 percent of the population in Gujarat live in rural areas, and 52 percent of the total workforce in the state depend on agriculture for their livelihoods ([Mishra 2015](#)). Finding ways to provide access to electricity for these areas was critical for Gujarat's industrial development. Before 2003, all Gujarat's electricity supply (agricultural, residential, industrial and commercial) ran through a common feeder. In 2003, the government of Gujarat introduced the Jyotigram Yojana Scheme (JGY) to

increase rural lighting for all households. The JGY bifurcated the feeders so that electricity needed for agriculture ran through a separate feeder than electricity needed for non-agriculture uses. Thus, a household can have one connection for their domestic uses inside their home and a separate one for their agricultural uses in their fields. By 2006, over 90 percent of Gujarat's 18,000 villages were covered under the JGY ([Shah 2008](#)). Termed their flagship energy program, the JGY has been celebrated for providing agricultural activities with eight uninterrupted hours of supply per day and 24/7 power supply for non-agricultural uses ([Mishra 2015](#)).

Numerous studies have assessed the impact of JGY on the rural villages in which electricity had been introduced. For example, [Mishra 2015](#) found improvements in more households consuming electricity, as well as reductions in overall transmission and distribution losses, and increased duration of electricity. While such prior work has aimed to document the number and quality of electricity connections, it has not evaluated the effect of such access on rural households. Furthermore, there is limited knowledge on the different effects electrification may have on individual household members, and women in particular. Given the important role women play in development, understanding the effect of electrification on their daily life may be particularly important. Indeed, a roundtable on Gender and Energy organized by the Prayas Energy Group specifically identified the need to study Gujarat as a successful case of recent village electrification efforts ([Prayas 2014](#)).

The Gujarat region is strongly embedded in caste relations and feudal culture, which have kept the position of women in society largely the same despite changes experienced within economic and political spheres ([Desai and Jain 1994](#)). In Gujarat, as in much of the developing world, women are largely responsible for household work and often work in the fields for wages. Despite all this work, women rarely have their own form of disposable income and often have their

wages paid to their husband ([Interview with respondent 10](#)). Furthermore, women and girls do not commonly attend school. Gujarat women make up about 48 percent of the population, yet comprise 67 percent of the illiterate population ([Government of India 2011 Census](#)). The overall result is that Gujarat women are rarely involved in deciding matters of the land and home. Prior studies would surmise that Gujarat's increase in rural access to electricity should help alleviate such gender disparities, yet these potential benefits have not been fully explored and are thus the focus of this study.

1.2 METHODS

This project's goal is to evaluate how household members are consuming electricity beyond having access, for women in particular in rural communities in Gujarat, India. As there is a dearth of prior theory to inform this distinction between electricity access and usage, I relied on grounded theory building methods ([Glaser and Strauss 1967](#), [Yin 1994](#), [Eisenhardt 1989](#)). In these methods, I conducted interviews and surveys with key respondents and triangulated that data with interviews with other key stakeholders in the region. In iterating between this data and prior theory, I formulate key findings and develop new testable propositions that could better guide future research.

The core data for my analysis was a detailed household survey that asked respondents about the availability of electrical appliances, their location within the home, and who uses them. In building this survey, researchers from both the University of Pittsburgh and the Gujarat Institute of Development Research reviewed and amended the survey to ensure its clarity and accuracy. A local organization ANANDI then reviewed the survey to ensure it was culturally sensitive to the

local Gujarati context. Finally, I then piloted the survey with a translator to ensure respondents accurately understand the survey and that it could be communicated in the local language. In conjunction with the surveys, I also conducted interviews where I asked a mix of semi-structured and unstructured questions to better understand the reasoning behind each respondent's survey answers ([Appendix C](#)).

To deploy my surveys, I used a site-based sampling approach that collects data through sampling a key site where the population of interest is known to frequent. In this way, sampling is likely to be more representative in that it is likely to lead to respondents that cross kinship lines. To accomplish this, I partnered with ANANDI, a women's empowerment organization based in the state of Gujarat, and its subsidiary organization, Mahila Swaraj Munch (MSM), which operates on the ground in the Bhavnagar district of Gujarat. Such partnerships were essential for the successful deployment of the study as village members typically confine trust to their local family and community. Both ANANDI and MSM provide key services that most local households use such as accessing political programs and facilitating participation in local government initiatives.

The specific Gujarati districts and villages were chosen by MSM based upon areas where they knew many locals who use their services, the ability to access the village, and to ensure as broad a range of demographics and locations were represented in the study. The farthest village in the study is located two hours away from the main town of Sihor in Bhavnagar. Using MSM contacts in the community, I first talked to women whom they assisted. To confirm the representativeness and robustness of the sampling procedure, I then also approached neighboring women at random once in the village and as I gained trust and was exposed to more women. Using constant comparative analysis (analyzing interviews as they were held to identify trends and gaps, [Glaser and Strauss 1967](#)), I further approached women for surveys and interviews to both reinforce

the characteristics of my site-based sample and address any demographic gaps that were discovered in this sample as it was being collected, such as the household's caste.

In deploying the surveys, I focused on interviewing women because they tend to spend more time in the house, and are often responsible for all domestic work. I thus argue that women have the best understanding of household appliance use patterns. My sample includes 31 women, in 13 villages, and 2 districts (15-16 women per district). The limited sample size is a result of the necessary level of specificity needed to gather the detailed electricity access and usage data of interest to this study. While I was primarily interested in women's responses, seven surveys were conducted in the presence of the male head of household. These took place when the man of the house was at home when we arrived to do the interview, so cultural norms precluded their absence. The males did not disagree with the female responses, and those responses were not significantly different from the responses other women provided without their husband present. In fact, when the males contributed to the answers, they usually focused on pricing and agrarian needs and did not focus on issues of usage. Thus, while females were the primary focus contributor to the study, we are confident that their responses do indeed reflect the views of all decision-makers in the household, both male and female, with regard to access and usage of appliances.

All women were individually contacted through the phone or in person to explain the study and ask for their consent in participation. Surveys were conducted in-person verbally through a translator. Women were only contacted and visited once for the interview, which was typically conducted in their homes and lasted on average between 20-40 minutes. Data collection was done over a two-week period. Interviews began with fact-based questions before shifting towards more open-ended perspective questions, which has been shown as an effective way to help mitigate recall bias ([Eisenhardt 1989](#)).

Finally, in addition to the women sampled and to enhance the external validity of my findings, I also actively sought the views of other stakeholders in the area. I conducted two interviews with a local government official and an electrical engineer, and triangulated my survey and interview results from my female respondents with these additional interviews. I also shared my results with my NGO partners to confirm that these results reflect their observations on-the-ground. This approach of using both surveys and interviews in conjunction with external contextual understanding is indicative of the iterative approach needed to ensure rigorous grounded theory building ([Glaser and Strauss 1967](#), [Yin 1994](#)).

1.3 FINDINGS

1.3.1 Household Information

The interviews began by gathering basic household information to subsequently contextualize their electricity usage across the sample. Among the various social groups, eight women self-identified as a part of Scheduled Castes, thirteen as Other Backward Classes (OBC), seven as coming from the General Class, and three as Others. The average household had six to seven people, with a generally even distribution among the different age groups and genders. The majority of households had their head of household self-employed in agriculture or working as agricultural laborers, nine participants in each of these categories. Those self-employed in non-agriculture were close after with seven respondent households.

Average Household Size	6.2 people
Proportion of Land-Owners	23%

Table 1. Respondent Demographics

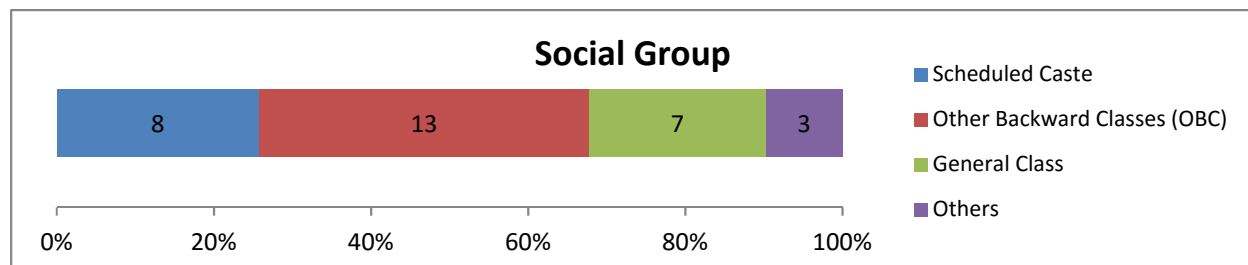


Figure 1. Respondent Social Groups

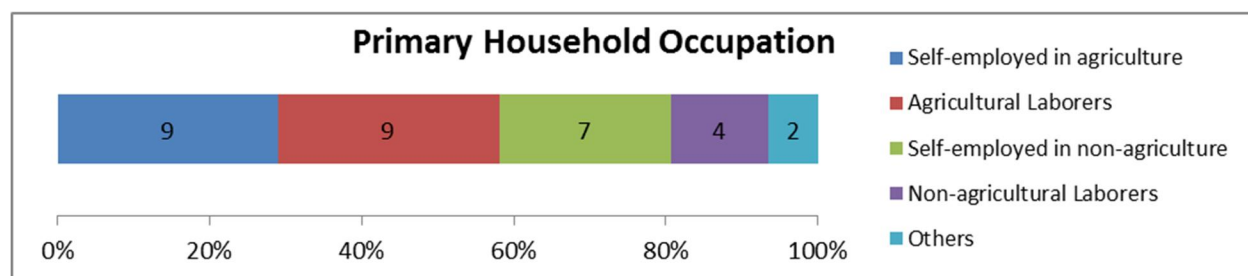


Figure 2. Respondent Primary Household Occupation

Relating the sample demographics to that of India, I find that my sample is generally representative of the average Indian rural village. In this sample, about 26 percent of my sample is of a Scheduled Caste whereas India's Scheduled Caste population is about 18.5 percent of the total rural population. However, this sample does not include any Scheduled Tribe populations, which make up about 11.3 percent of India's total rural population. Relative to the household's primary occupation, approximately 39.3 percent of India's rural population is agricultural laborers as compared to about 29 percent of this sample. 82 percent of India's rural population is Hindu, which is 100 percent of our sample's self-identified religion.

1.3.2 Household Connectivity

Respondents were then asked to describe the extent of their connectivity access. Participants in this study all said that their area has had electricity access for the last 30-40 years, some with a fair amount of uncertainty on how many years ago, but with the same conviction that there had been grid connectivity since long before the Jyotigram Yojana (JGY) electrification scheme. However before JGY, various cutoffs and the instability of their connection prevented them from using electricity to a great extent. Now, according to respondents, all have connection through the JGY feeders and stated that their connectivity considerably improved after JGY was introduced.

Of the 31 participants, 30 had a domestic electricity connection from the centralized grid. Figure 3 below shows the distribution of how respondents would describe the reliability of their electricity connection in reference to when they want to use electricity. The majority report that they “always have electricity when they want it” while just over one-fourth of respondents stated that they have some trouble accessing electricity. The three respondents who said they “rarely” have electricity access when they want to use it all came from the Dhamnaka village of Umralla, which indicates that it may be a particular issue within that village.

In terms of power outages, just more than half of the respondents report that they have 24/7 connection without any cuts or irregularities. Figure 4 shows the breakdown where eight report that Friday contains outages, that for some of them last the entire day, while for others last 0-4 hours. Some of these cutoffs come with notices from the electricity board announcing their occurrence while others do not, and most respondents indicated that they know they have cuts on

Fridays but it comes without regularity of the time of day. When asked what they do when there is a blackout, they all report that they use kerosene lamps for light.

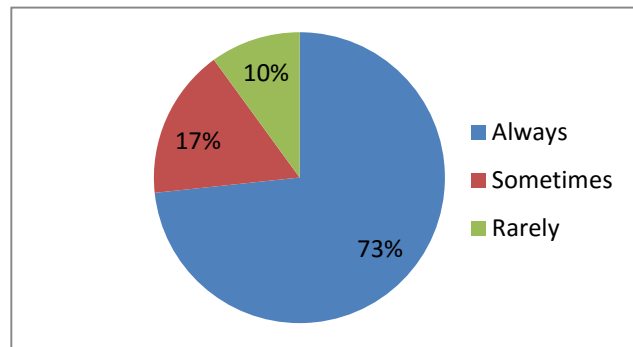


Figure 3. When you want electricity, is it available to you?

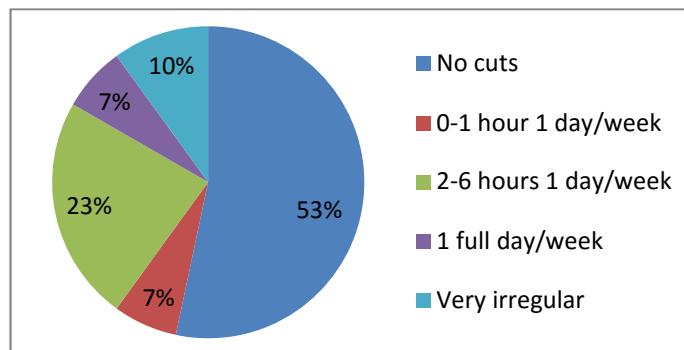


Figure 4. Consistency of Supply

“X hours 1 day/week” indicates that power is lost for that amount of time only one day per week

1.3.3 The Financial Side

The majority of households, 73 percent, report that they had no problem paying their electricity bills regularly. Of the other 17 percent who said that they had difficulties paying their bill, they stated the need to take out loans, mortgage their own jewelry, or simply have their connection cut multiple times in a year when they could not get the necessary money. Of the 30 households with a domestic electricity connection, one is connected illegally to another’s line due

to the inability to pay the electric bills when they had their own connection. All respondents commented on how their electricity use is seasonal and thus billing fluctuates throughout the year, with summers and times of intense heat producing the larger bills which lead families to find ways to reduce their consumption such as sleeping outside at night.

Households were asked to show their electricity bill if they were able to, which twenty were able to provide while the other ten reported the quantity verbally. Those reported verbally fell within the average range of other respondents. These numbers are from the most recent bill they had received for the months of March-April, with a few deviations. Most households were charged within the range of 200-1600 Rs. (\$2.9-\$23.5 USD).

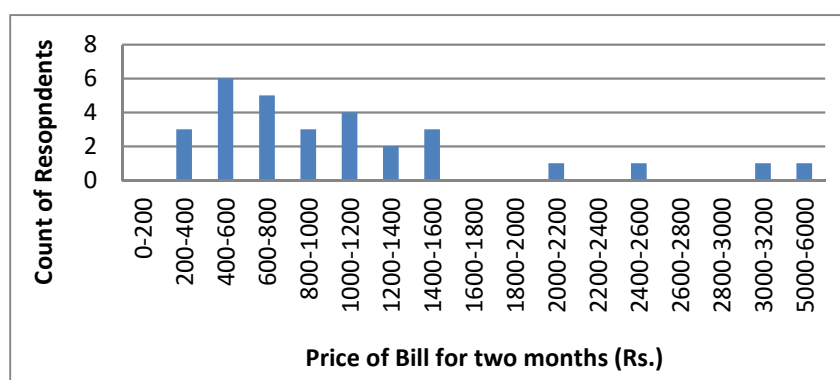


Figure 5. Most Recent Electric Bill Pricing

1.3.4 Household Electricity: Access to Goods

Accessibility is an indicator of which electric appliances are affordable to each household. Each household reported which appliances they owned and the associated quantity, allowing us to identify key appliances that were ubiquitous across households and those that were only owned by select few. Figure 6 shows the percentage of households that have access to various key appliances and how that varies across key socioeconomic indicators (i.e. problems with payment vs. no

problems with payment, landowner vs. non-landowner, high vs. non-high castes). These socioeconomic breakdowns were the main dimensions I asked interviewers to report on in which there was variation (unlike religion where all identified as Hindu) and were considered important to investigate when observing patterns. Through breaking down respondents into these various categories, it proves that these divisions are not largely significant and that there is a clear overlying message.

<i>Have or Not (Access)</i>	<div> <div>H2O</div> <div>Sewing</div> </div>											
Household Matrix	TV	Fan	Mobile	Bulb	Pump	Fridge	Iron	K Light	K Fan	Mixer	Machine	Grinder
No problems with payment (N=22)	82%	100%	95%	100%	64%	64%	50%	64%	18%	59%	27%	23%
Problems with payment (N=8)	75%	88%	88%	100%	25%	25%	38%	13%	0%	0%	0%	0%
Land Owner (N=8)	100%	100%	100%	100%	88%	75%	100%	100%	25%	88%	63%	38%
Non-Land Owner (N=23)	70%	91%	91%	96%	39%	43%	26%	30%	9%	30%	4%	9%
Kids (N=19)	79%	95%	89%	100%	53%	53%	53%	58%	5%	47%	26%	21%
No Kids (N=12)	75%	92%	100%	92%	50%	50%	33%	33%	25%	42%	8%	8%
High Caste (N=7)	100%	100%	100%	100%	86%	71%	86%	86%	29%	71%	43%	14%
Non-High Caste (N=24)	71%	92%	92%	96%	42%	46%	33%	38%	8%	38%	13%	17%

Figure 6. Ownership of Appliances

(More green=higher percentage of households who own those appliances; more red=lower percentage of households who own those appliances)

Across household socioeconomics, there are trends in prevalence of certain appliances indicated by the colored heat map in Figure 6, which shows a clear differential between what almost every home owns and what only a few can afford to. Commonly reported goods across socioeconomic indicators were present in generally 70 percent or more of homes. In this study that includes a majority of households owning a Light-Bulb (100%), Fan (97%), Mobile Phones (97%) and a Television (60%). Initially, lighting is the very first usage of electricity and the homes always have light bulbs if they have electricity, thus representing an easily accessible and basic electric good. Fans were the second-most prevalent appliance and were cited as necessities for comfort of the whole family (Interviews 8, 9, 11, 12, and 26). Mobile phones and televisions are also generally

accessible for electrified homes in the study area; fitting, which other studies find to be the case for India, more generally ([Barnes 2011](#)). Overall, these results are consistent with the general literature about appliance ownership in rural households ([Bose 1993](#), [Kohlin et. al. 2011](#), [Lenz et. al. 2017](#)).

Less commonly reported goods appear to be more specialized appliances found at much smaller rates across households, with at most 50 percent of homes owning them. As in other studies in rural areas ([Lenz et al 2017](#)), these rarer appliances include the sewing machine, grinder, mixer, refrigerator, and water pump. I specifically see socioeconomics playing into ownership rates of these types of appliances. As with prior studies, having lower socioeconomic status constrains what electric appliances such households can own ([Sadath and Acharya 2017](#)). For example, 86 percent of high caste families in our sample have water pumps, irons, and lights in their kitchens compared to 33-42 percent of non-high caste households. The most distinct difference exists between landowners and non-landowners, most likely due to the wealth required to own land and the greater demand for electricity-powered appliances for agrarian uses. Overall, homes of higher socioeconomic status see higher rates of prevalence across these more specialized appliances while those in the lower socioeconomic tiers do not regularly have such appliances.

However, electricity is not used as an actual fuel for cooking which is a well-noted trend ([Kohlin et. al. 2011](#)). Most respondents, 71 percent, use firewood as their primary fuel. Most households use more than one fuel for cooking, most often a combination between firewood and gas. Of all households, 84 percent use firewood as one of their cooking fuels while 32 percent utilize gas. Electricity and dung cakes are used by a small percentage of households and are often the secondary or tertiary cooking fuel utilized. Of those using firewood, most of the women, 62 percent, spend three to four hours daily gathering firewood. In this is an important distinction,

women report that cooking is the most important function electricity helps with but electricity is not actually used for cooking itself.

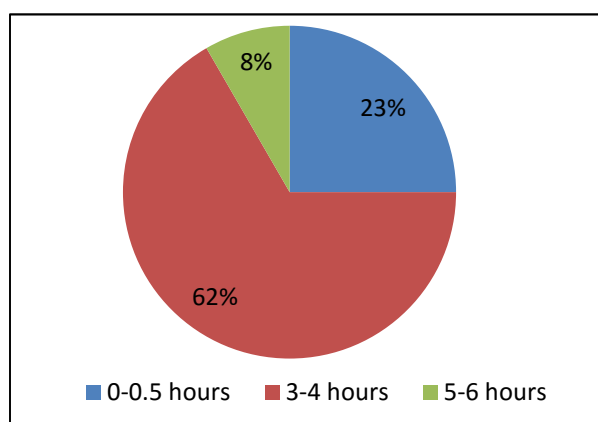


Figure 7. Hours Spent Gathering Firewood

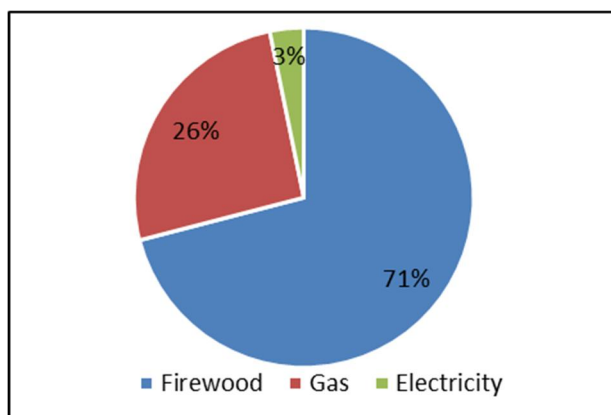


Figure 8. Primary Cooking Fuel Used

1.3.5 Household Electricity: Usage of Goods

In addition to access, each household reported the quantity and type of appliances owned to identify the average points of use each household has, as depicted in Figure 9. This is an indicator of affordability as well, displaying the ability to purchase multiple of the same item. It is evident that certain goods have high frequencies within homes, averaging over three of each in a household (including fans and light bulbs) and the mobile with most having between two-to-three.

As well, this indicates the household recognizing a need for multiple of these appliances ([Yohanis 2012](#)). Amongst the goods that are less common, households generally have less than one per unit on average. Along socioeconomic lines, I do see higher averages amongst higher socioeconomic households compared to the other households. Overall, these values further reinforce the robustness of the findings in Figure 6.

Average Points of Use Household Matrix	H2O								Sewing			
	TV	Fan	Mobile	Bulb	Pump	Fridge	Iron	K Light	K Fan	Mixer	Machine	Grinder
No problems with payment (N=22)	0.86	3.73	2.55	4.91	0.64	0.64	0.50	0.64	0.18	0.59	0.27	0.23
Problems with payment (N=8)	0.75	2.63	1.25	3.13	0.25	0.25	0.38	0.13	0.00	0.00	0.00	0.00
Land Owner (N=8)	1.00	4.75	3.38	5.88	0.88	0.75	1.00	1.00	0.25	0.88	0.63	0.38
Non-Land Owner (N=23)	0.74	2.83	1.74	3.74	0.39	0.43	0.26	0.30	0.09	0.30	0.04	0.09
Kids (N=19)	0.84	3.21	2.16	3.84	0.53	0.53	0.53	0.58	0.05	0.47	0.26	0.21
No Kids (N=12)	0.75	3.50	2.17	5.00	0.50	0.50	0.33	0.33	0.25	0.42	0.08	0.08
High Caste (N=7)	1.00	4.43	2.86	6.00	0.86	0.71	0.86	0.86	0.29	0.71	0.43	0.14
Non-High Caste (N=24)	0.75	3.00	1.96	3.79	0.42	0.46	3.00	0.38	0.08	0.38	0.13	0.17

Figure 9. Average Points of Use

(More green=higher average number of appliances per household; more red=lower average number of appliances per household)

Distinct from affordability, household members also make decisions with regard to how they then use these appliances within the home. The women interviewed were asked which appliances they use and which their husband and children use as well. In their responses, there appear distinct differences between which appliances women report themselves using as compared to their partners. With certain appliances, women largely report lower rates of use as compared to their husband such as with the television, mobile, sewing machine, grinder and mixer (Figure 10), all irrespective of affordability. Figure 10 describes how women report themselves as primary users of each appliance. In addition, we had women report the usage of each appliance for their husbands as well. As demonstrated below, women report varying levels of usage for appliances that are generally considered public goods (the TV, Fan, Mobile). For their husbands, women

report 100 percent usage of shared goods such as the TV, Fan, Mobile, Bulb, and Water Pump while no usage of appliances related to female-work (Iron, Mixer, Sewing Machine, Grinder, Kitchen Light/Fan).

Primary User of Appliance	H2O							Sewing				
Female Head of Household Matrix	TV	Fan	Mobile	Bulb	Pump	Fridge	Iron	K Light	K Fan	Mixer	Machine	Grinder
No problems with payment	72%	91%	71%	100%	93%	100%	100%	100%	100%	100%	100%	100%
Problems with payment	33%	57%	43%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Land Owner	88%	88%	88%	100%	86%	100%	100%	100%	100%	100%	100%	100%
Non-Land Owner	50%	76%	57%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Kids	73%	89%	65%	100%	90%	100%	100%	100%	100%	100%	100%	100%
No Kids	44%	75%	67%	100%	100%	100%	100%	100%	100%	100%	100%	100%
High Caste	71%	71%	86%	100%	83%	100%	100%	100%	100%	100%	100%	100%
Non-High Caste	59%	86%	59%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Figure 10. Female Head of Household Matrix

(More green=higher number of women reporting as primary user of appliance; more red=lower number of women reporting as primary user of appliance)

For the common appliances across households, women tend to respond similarly with which they are primary users of and which they do not use as commonly as their husband or children. No woman commented on disparity of usage with lighting, and most remark at how integral having light in the home is for completing and providing flexibility to their housework ([Interviews 2, 3, 4, 5, 6, 7, 9, 10, 16, 26, and 28](#)). With the fans, very few women report not using the fans at all, but those who did would comment “I don’t use the fan, that is for my children and husband” ([Interviews 24, 25, and 28](#)). All women report that their husbands and children are primary users of the television and mobile phone, while 40 percent to 50 percent of respondents cited not being a primary user of the appliance themselves. One woman describes her husband as the primary and constant consumer, “my husband uses electricity the most, constantly using the fan and the television” ([Interview 2](#)), while another interviewee reports, “I watch TV for maybe an hour in the afternoon, only if I have some free time” ([Interview 31](#)). Ten women report their

family having mobile phones, which they (the women) did not use, “the men use the mobiles, not me” ([Interview 14](#)). Overall, most women report using the common appliances but at distinctly lower rates than their husband and children who are reported as consistent primary users. Women are thus users of these appliances but not the primary users within the family, underlining their perception of limited use relative to others in the family.

Products like the grinder, mixer, and sewing machines, which are rarer, are used almost exclusively by women. Primarily owned by households with higher socioeconomic status, women report these appliances as secondary to main household functions where “we only use the mixer and grinder when guests come” ([Interview 10](#)). These goods appear to be specialty items bought as a status symbol, indicating a family’s ability to serve guests and falling within the domain and responsibility of the woman. Of the clear demarcation, there was one husband who also was reported as using the sewing machine due to him and his wife both working as tailors. All other sewing machines were reported as being for personal household use that only the woman of the house tended to.

On the other hand, there are goods where women report common usage amongst all family members within the home and their use does not appear to depend on the familial role. Women cite these goods as the Light bulb, Fan, Refrigerator, and Water Pump. The light-bulb and fan are usually positioned in the common room of the home. The water pump varies between agricultural and domestic spaces but generally is used by all members of the family. With more general purpose and access, these appliances were noted as common-use appliances that relate to everyone in the home with women generally seeing themselves as primary users alongside their husband and children.

1.3.6 Perceived Impacts

Afterwards, women were asked to answer true or false to a list of statements targeted at understanding where they see the impact of electricity on their lives. One hundred percent of respondents agreed that their electricity access allows them to work longer days, while all respondents stated that it is both easier and faster to complete their household work. When women were asked to elaborate on how it impacts their lives, the main response revolved around providing more comfort and flexibility in their day-to-day responsibilities of household work. They are no longer dependent on the sun's schedule for when they have to cook, and they can do the necessary work in the comfort of better lighting and a fan.

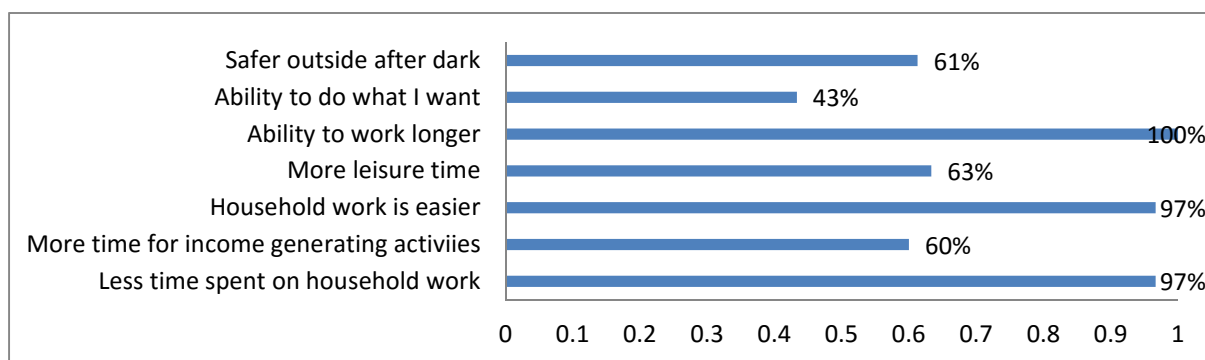


Figure 11. Self-Assessed Benefits

Approximately 60 percent of respondents said that having electricity enables them to have some amount of leisure time to themselves and the ability to manage their responsibilities and engage in income-generating activities. When asked to describe their leisure activities, the women responded that they rest in-between chores or that they take an hour or two during the day to watch television. For 60 percent of respondents, they feel safe going outside their homes after dark in

their village. All of those who responded “True” to this statement come from villages with streetlights, either solar or electric. Umralla was the only district where the respondents said their streetlights were solar-powered, installed because of a government scheme. For the 40 percent who do not feel it is safe to go outside after dark, 75 percent live in villages that do have streetlights, but they commented that there are not enough and are typically situated only along the main road of the village. The women report that to go outside they use the light on mobiles, an electric powered torch, or they simply do not go outside after dark.

Less than half of respondents, 43 percent, said that with electricity they can do what they want. All but one of these respondents use a mixture of energy sources for cooking, mainly gas, kerosene, and even one person uses some electricity. When respondents answered false to the question, they typically responded that electricity does not touch that part of their life, in which they are still restricted to household responsibilities and are at the mercy of the males in the household. Two women responded that they are still not free, and that electricity has just increased the workday of the woman ([Interviews 9 and 14](#)). A few women commented that when their household faces difficulties paying the electricity bill, they often mortgage their own jewelry. When asked about their personal use of such comfort appliances as the fan, the television, and the mobile, none were personally used by 100 percent of the women who have them in their homes.

1.3.7 A Stakeholder’s View

Throughout the study, I spoke to two different stakeholders to gain their view on how JGY has impacted their community. Speaking with the head of the Ramdhari village Panchayat, the elected head of the village’s local self-government, he asserted that JGY was a huge benefit to the village and all its members. He asserted that with the quality electricity it provided, there are now

increased employment opportunities with sewing machines, diamond shaping, and improvements to agricultural productivity with water pumps. With greater farming productivity, more laborers can be hired to work in the fields. Before JGY, according to him, there was unemployment and people were migrating to nearby urban centers in search of work. Sometimes electricity would be cut for entire weeks and was largely unpredictable. Now, he reports that there is no migration to urban areas and that people can sustain their lives in the village because of quality electricity connection. Responding to complaints about lack of street lighting, the panchayat leader reports that they have difficulties with funding to invest in streetlights. They rely on each household paying a small flat tax to contribute to the Panchayat's funds for village projects but many households do not pay this. He remarked that they focus on trying to use the money they get from the government for the most pressing issues, which have been largely water-related.

In speaking with the Deputy Engineer of JGY for the Sihor Taluka District, he described fully the way in which JGY has transformed the context of rural electricity in rural life. A primary point of his was that before JGY the lack of a quality electricity connection, strong enough to be reliable and to support various points of use, hindered village businesses and stunted the village economy. Another main point is that before JGY, villagers were not able to do anything after dark, inhibiting economic activities as well as personal activities that allow people to lead full lives. Now, they have seen a decline in migration to urban centers, an increase in village business, and the simple ability for people to continue their activities after dark, enabling greater income generation and life satisfaction.

When asked about how he thinks women benefit from JGY, he remarked that as overall living standards have increased in villages, this has lifted the quality of life for women with it. Women can use appliances with electricity such as a grinder, mixer, and washing machine due to new

stability of power, which help in performing household work. He sees the supply of stable, quality electricity as the primary driver of Gujarat's development. From his perspective, the entire country should implement their own version of the JGY scheme and that it would see 100 percent success rates around the country.

2.0 DISCUSSION

Given these results, there appears to be a dynamic relationship between access and appliance use (and thus consumption of electricity) among the households. There is a distinction with the role of accessibility in deciding which products are available to a household, yet even along the same lines of affordability there are distinctions in how these products are used within the household. Through this observation, the appliances found in the interviewed households were divided into categories based on accessibility as well as reported internal usage. Table 2. **Energy Embeddedness** describes my organization of the information women report between those goods prevalent versus rare in households and those goods where usage is linked to social relations versus unlinked. Here, access lines the x-axis indicating the goods we found large percentages of households having, what I assume to be because of affordability and perceived value. “More” goods are thus those I find many households having while “Less” goods are found far less frequently. “Male” and “Female” goods are those I argue have linkages to social relations while “Common” goods do not. “Common” goods are those women report as using to the same extent as their husband and children whereas “Male” and “Female” goods where they report usage distinct from others in the household.

Access (Affordability)		Usage (Social Relations)		
		<i>Male</i>	<i>Female</i>	<i>Common</i>
	<i>More</i>	More Prevalent Goods Used Primarily by Males TV; Mobile	More Prevalent Goods Used Primarily by Females Kitchen Bulb; Kitchen Fan*	More Prevalent Goods Used Commonly Bulb; Fan
	<i>Less</i>	Less Prevalent Goods Used Primarily by Males	Less Prevalent Goods Used Primarily by Females Sewing Machine; Iron; Mixer; Grinder	Less Prevalent Goods Used Commonly Fridge; Water Pump

Table 2. Energy Embeddedness

**The bulb and fan itself are basic goods, made role-specific when in the kitchen, but are found rarely within the kitchen*

In addition to the largely discussed topic of access, there is a clear distinction between a woman's role in the household and her subsequent usage of electricity compared to the other members of her family. The theory of embeddedness, that social relationships dictate economic decision-making, manifests itself in energy usage here. This explores how a woman's social role and social relationships within the home may correlate with these discrepancies in what is prioritized within the household, how energy decisions are made, and who truly uses the energy when a home is electrified.

The appliances that benefit the individual user are far more attributed to social relationships and networks, women using them less because of their lower positioning in the family. Even between caste differences, I see this holding that women use it less than their male counterparts and children. I find that women are sensitive to the amount of personal usage they are taking up, frequently reporting less usage of entertainment or recreation appliances than her husband or children. Financial struggles within the household correlate to women reporting that they are not primary users of such goods to an even greater extent. Also, the presence of electric appliances in

the kitchen, a female-dominated space, shows that they are missing basic appliances that the household has prevalent elsewhere. This can possibly be a result of a lack of awareness as to how important a light and fan in the kitchen are for a woman's health and safety ([Yohanis 2012](#)) which has not been a priority area in energy policy ([Parikh 2011](#)). As well, this can be related to the woman not prioritizing her own discomfort because of social hierarchies and relationships that do not involve her in the decision-making process in the household, and thus does not speak to her needs ([Desai and Jain 1994](#), [Day et. al. 2016](#)). Ultimately, there is a gap in how a woman is using the electricity within a home compared to other members of the household.

In further understanding this gap, the stakeholders' and the women's reflections shed light on how practitioners view women's engagement with electricity as compared to the women themselves. From the interview with the JGY engineer, he believed that women were benefitting greatly from the improved electricity access through usage of appliances such as a grinder, mixer, and washing machine. These appliances help in performing household work and thus, as he remarked, enabled women to enjoy a higher quality of life. Given the interviews with women, there is a distinct disconnect between what the local worker thinks his initiative is achieving for women and what women are experiencing. None of these are common household appliances and are typically found in the higher socioeconomic households. Further, women who owned these goods report that the grinder and mixer are used infrequently and only to serve guests, indicating that it has only raised the expected standard of work women are expected to produce and does not alleviate their daily responsibilities ([Lenz et. Al. 2017](#)). Electricity does in fact lengthen the ability for all people to work longer hours due to having lighting after dark, but does not largely go towards the appliances that would drastically impact the amount of time women spend gathering fuel for cooking and cooking itself. A few women commented on how now they are even busier,

without anything enabling their freedom and “now I am always just working” ([Interview 9](#)). Lacayo argues that the typical way in which electricity provision is thought to impact women ignores the large difference between the way in which men and women interact with energy sources ([Lacayo 2006](#)). This study shows that there is a need for further inspection as to electricity usage aside from access, with specific regard to women’s needs and position in the social hierarchy ([Kohlin et. al. 2011](#), [Kaygusuz 2011](#)).

2.1 CONCLUSION

I argue this helps us rethink access from the perspective of usage and I hope this framework serves as a platform for future empirical testing on larger data. This topic merits a larger study over a longer period of time with a more robust research design in order to truly explore the previous findings. With more women sampled from more parts of the country, a clearer picture of how rural households and rural women engage in electricity usage can be developed. This can illuminate how electrification initiatives can more effectively target the energy dynamics within households to ensure that appliances which will contribute to a woman’s agency and economic progress are being bought and used. This can then feed into other studies in developing countries which continue to research the linkage between electrification and women, such as in South Africa where a study found that female employment significantly increases with electrification ([Dinkelman 2011](#)). Further, this emboldens the call for local organizations focused on empowering women, such as the organization I worked with, to be integrated into the strategy for extending electrification. This study exposed some elemental components of women’s lives with regards to electricity access, and much more can and should be done to unearth how women are impacted by

these changes in the home. This kind of insight will be useful in crafting programs and policies meant to address issues of women, cleaner energy, and fuel use. Development does not come through infrastructure development alone, and with goals of true human development an understanding of the dynamics that keep women from benefiting from these programs is required.

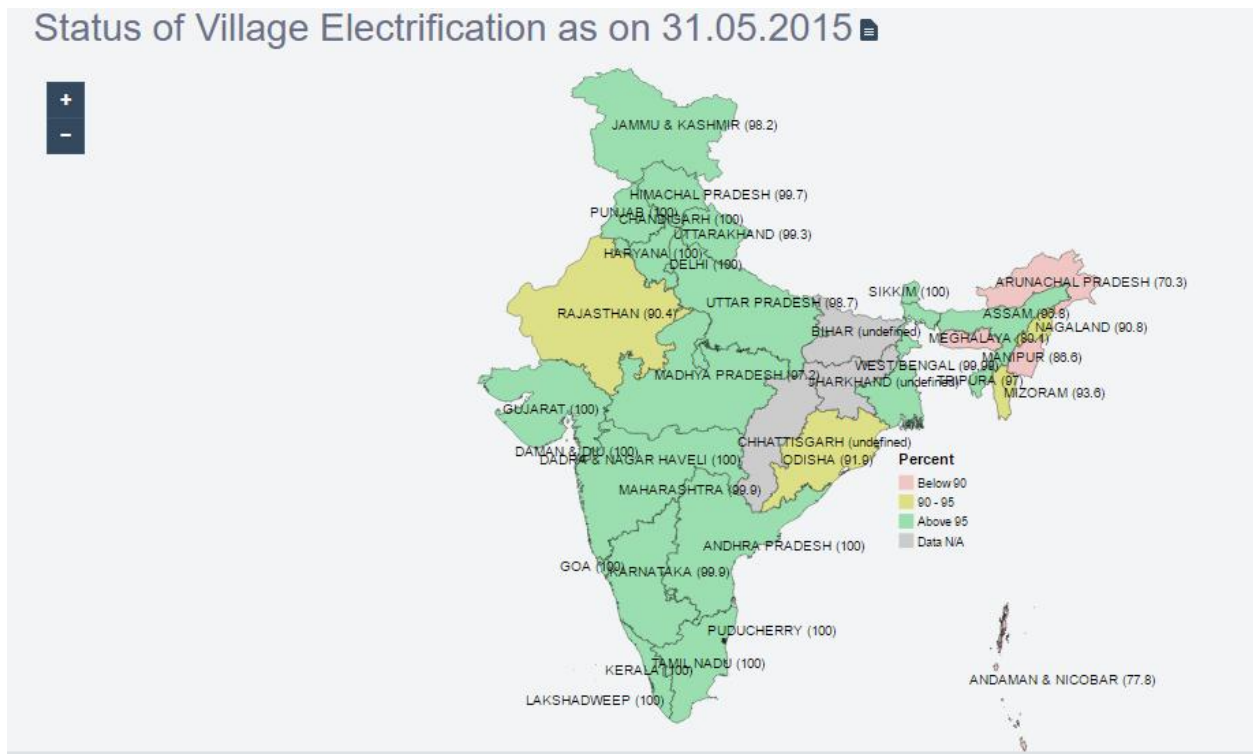
APPENDIX A

INDIA'S RURAL ELECTRIFICATION PROGRAMS

<u>Year</u>	<u>Program</u>	<u>Key Focus</u>
1948	Electricity Act	Creation of electrical grid system Creation of State Electricity Boards and the Central Electricity Authority
1969	Rural Electrification Corporation Established	To promote rural electrification focused on agricultural use <ul style="list-style-type: none">• Irrigation pump electrification
1974	Minimum Needs Program	Rural household electrification
1989	Kutir Jyoti Yojana	Single point light connections for households below the poverty line
2001	Pradham Mantri Gramodaya Yojana (PMGY)	Rural Electrification added to human development program
2002	Remote Village Electrification (RVE)	Use of stand-alone, solar photovoltaics and other non-conventional energy sources, for remote villages
2002	Rural Electrification Supply Technology (REST)	Renewable energy and decentralized technologies from locally available resources
2003-04	Accelerated Rural Electrification Program (AREP)	Electrification of un-electrified villages through subsidizing electricity companies
2005	Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY)	Electricity all villages with more than 100 people, free electricity connections to households below the poverty line
2005	Remote Village Electrification	Population of less than 100 inhabitants. Use of decentralized solutions
2009-10	The Jawaharlal Nehru National Solar Mission	Large grid of solar plants as well as off-grid and decentralized solar solutions
2015	Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY)	Separation of agriculture/non-agriculture feeders

APPENDIX B

CATEGORIZATION OF STATES



APPENDIX C

SAMPLE SURVEY

Household characteristics				Of household member	
1. how many people do you share a kitchen with? (by age and by gender)	Age	Male	Female	10. sex (<i>male-1, female-2</i>)	
	Children < 6				
	Children 6-18				
	Adults 18-30				
	Adults 30-50				
	Adults 50-80				
2. household type (code)				11. marital status of respondent (code)	
3. religion (code)					
4. social group (code)					
5. whether owns any land (<i>yes-1, no-2</i>)					
6. is any member of the household a regular salary earner? (<i>yes-1, no-2</i>)					
primary sources of energy for...	8. cooking (code)				
	9. lighting (code)		Average time spent <u>per day</u> gathering lighting sources	Average cost <u>per month</u> spent on lighting sources	
		CODES			
item 2: household type :		<i>self-employed in agricultural labour – 1, construction work – 2, farming/fishing – 3, others – 4</i>			

item 3: religion :	<i>Hinduism-1, Islam-2, Christianity -3, Sikhism- 4, Jainism - 5, Buddhism - 6, Zoroastrianism - 7, Tribal - 8, others -9</i>
item 4: social group :	<i>Scheduled Tribes - 1, Scheduled Castes -2, Other Backward Classes- 3, NT-DNT - 4, others -9</i>
item 8: primary source of energy for cooking :	<i>coke, coal - 01, firewood and chips - 02, LPG - 03, gobar gas - 04, dung cake - 05, charcoal - 06, kerosene - 07, electricity - 08, agricultural residue - 09, others - 10, no cooking arrangement - 11</i>
item 9: primary source of energy for lighting :	<i>kerosene - 1, other oil - 2, gas - 3, candle - 4, electricity - 5, others - 9, no lighting arrangement - 6</i>
item 11: marital status :	<i>never married - 1, currently married - 2, widowed - 3, divorced/separated - 4</i>

Use of Electricity by the Household

1. Are you a beneficiary of 'Jyoti Gram Yojana'? (yes -1; no-2) _____
2. How many years ago did your household get electricity? _____
3. Did you have a choice in acquiring electricity? (yes-1, no-2) _____
4. Place an 'X' in the box of the appliances you use electricity for in your home and indicate the quantity of each you have in your home.

	'X' if within home	Quantity within home
Electric bulb		
Television		
Water Pump		
Electric Fan		
Refrigerator		
Electric iron, heater, toaster, oven & other electric heating appliances		
Other cooking/household appliances		
Mobile handset/telephone instrument		

5. Place an 'X' next to the times your household would like to use electricity in a normal day?

Before 5:00	
5:00-8:00	
8:00-12:00	
12:00-15:00	
15:00-19:00	
19:00-22:00	
22:00-24:00	

6. Place an 'X' next to the statement that reflects your electricity access reliability:

We <u>always</u> have electricity when we want it	
We <u>sometimes</u> have electricity when we want it	
We <u>rarely</u> have electricity when we want it	

7. In the last week, how many hours a day does your household have electricity access?

Agricultural purpose	
Domestic purpose	

8. What was your average electricity bill for the last 3 months?

Agricultural purpose	
Domestic purpose	

9. What percentage of your monthly expenditure is spent on electricity? _____

10. Are you able to pay your electricity bill regularly without any problem? (yes-1, no-2)

_____ a. If no, what are the reasons?

11. Do you know the per unit charge of consumption for your electricity use? _____

12. Who is the primary user of electricity in your household for each of the listed activities?

Myself-1, My husband-2, My children-3, the whole family-4

Cooking	
Lighting	
Irrigation	
Enterprise Activity	
Other household activities	

Use of Electricity by Women in the Household

13. Which of the following gadgets do you operate on your own?

Electric bulb	
Television	
Radio	
Electric Fan	
Refrigerator	
Electric iron, heater, toaster, oven & other electric heating appliances	
Other cooking/household appliances	
Mobile handset/telephone instrument	

14. Do you think you have personally gained from having electricity at home? (yes -1, no -2)

15. If yes, how have you been impacted? Indicate whether the below statements are true or false (true-1, false-2)

I spend <u>less</u> time doing household chores	
I am able to devote <u>more</u> of my time to income-generating activities	

It is <u>easier</u> to do my work	
I am able to spend <u>more</u> time engaging in leisure activities for myself	
I can work <u>longer</u> into the night	
I feel I have <u>more</u> ability to do what I want	

16. If no, please explain why you could not personally benefit.

17. How have others been impacted after gaining electricity? Indicate whether the below statements are true or false (*true-1, false-2*)

My children are able to study longer	
My husband is able to work longer	
Income from agriculture has increased overall	
My community is more connected to information sources	
My friends and I enjoy more entertainment sources	
My community has benefited from gaining electricity	
My community now has more difficulties with payment	

18. Has anything else changed for you since gaining electricity? (open response)

19. Which of the below community lighting sources are in your community? Place an 'X' to indicate existence.

Streetlights	
Lighting in Schools	
Anganwadi	
Others	

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